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# Request for grant of a patent

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| | | |
|---|---|---|
| 1. | Your reference | LB1609 |
| 2. | Patent application number *(The Patent Office will fill in this part)* | 0223572.9 |
| 3. | Full name, address and postcode of the or of each applicant *(underline all surnames)* | Pursuit Dynamics plc<br>Unit 1, Anglian Business Park<br>Orchard Road<br>Royston<br>Hertfordshire<br>SG8 5TW |
| | Patents ADP number *(if you know it)* | 8333072001 |
| | If the applicant is a corporate body, give the country/state of its incorporation | United Kingdom |
| 4. | Title of the invention | Fluid Mover |
| 5. | Name of your agent *(if you have one)* | Barker Brettell |
| | "Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)* | 10-12 Priests Bridge<br>LONDON<br>SW15 5JE |
| | Patents ADP number *(if you know it)* | 7442494003 |

| | | Country | Priority application number *(if you know it)* | Date of Filing *(day/month/year)* |
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| 6. | If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number | | | |

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| 7. | If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application | | |

8. Is a statement of inventorship and of right to grant of a patent required in support of this request *(Answer 'Yes' if:*
*a) any applicant named in part 3 is not an inventor, or*
*b) there is an inventor who is not named as an applicant, or*
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Continuation sheets of this form

| | |
|---|---|
| Description | 11 |
| Claim*(s)* | |
| Abstract | |
| Drawing*(s)* | 4 |

10. If you are also filing any of the following, state how many against each item.

| | |
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| Priority documents | |
| Translations of priority documents | |
| Statement of inventorship and right to grant of a patent *(Patents Form 7/77)* | |
| Request for preliminary examination *(Patents Form 9/77)* | |
| Request for substantive examination *(Patents Form 10/77)* | |
| Any other documents *(please specify)* | |

11. I/We request the grant of a patent on the basis of this application.

Signature Barker Brettell Date

**Barker Brettell** 10 October 2002

12. Name and daytime telephone number of person to contact in the United Kingdom Lance Butler Tel: 020 8392 2234

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# FLUID MOVER

This invention relates to a fluid mover.

The present invention has reference to a fluid mover having a number of practical applications of diverse nature ranging from marine propulsion systems to pumping applications for moving and/or mixing fluids of the same or different characteristics. The present invention also has relevance in the fields of heating, cleaning, aeration and agitation of fluids and fluids/solids mixtures.

More particularly the invention is concerned with the provision of a fluid mover having essentially no moving parts.

Ejectors are well known in the art for moving fluids by the use of a steam jet emitted into a duct in order to move fluids through or out of appropriate ducting or into or through another body of fluid. The ejector principally operates on the basis of inducing flow by creating negative pressure. Conventionally, the induced fluid enters the duct orthogonally to the axis of the jet.

USP 2 396 290 to *Schwarz* discloses a sludge system intended essentially as an apparatus for removing from storage tanks the accumulation of viscous tar or semi-fluid tar, oil sludges and the like. The *Schwarz* system has a throat body provided with an outwardly flared portion at one end, a steam intake nozzle extending into the body and having a central opening for the passage of material therethrough into the throat body, and a steam discharge nozzle at the flared end for drawing material out of the flared portion of the throat body. The principal objective of *Schwarz* is to provide a means whereby the difficult materials recited above may be fluidised by a combination of the impact of the steam initially at the

intake end of the throat body and the heat of the steam, the material being further subjected to the same action afforded by the discharge nozzle. The viscosity of the difficult material is thus reduced to improve flowability to allow pumping. It is to be noted that the flow of material whilst being assisted through the throat body has to pass from a wide bore nipple into a tapered section prior to the location of the primary steam nozzle, thus constraining the material and potentially causing blockages. Equally the throat body is of smaller dimension than the intake nipple and the tapered section, thus combining to create a constriction to the flow, albeit that the intention is to provide a concentration of impact and heat application for the purpose taught. The secondary or discharge nozzle fulfils a similar function to that of the primary nozzle to give a second stage impact and fluidising effect to the flowing material thus to enhance induction of the material through the system. The potential disadvantage of the *Schwarz* system is that by virtue of the convergent nature of the inlet to the unit and the constricted throat portion the free flow of fluid materials therethrough is likely to be difficult or restricted by the physical characteristics of the materials.

USP 3 664 768 to *Mays* concerns a fluid transformer of the straight-through type for sludges and other liquid/solids materials in which again the throat area converges, in this instance in a stepwise configuration thereby giving rise to potential impaction of the solids elements of the fluids passing therethrough. It is to be noted that Mays is silent regarding the nature of the impelling fluid.

An object of the present invention is to provide a fluid mover having essentially no moving parts having an improved performance than fluid movers currently available in the absence of any constriction such as is exemplified in the prior art herein recited.

A further object of the present invention is to provide a method of moving fluid.

According to a first aspect of the present invention a fluid mover includes a hollow body provided with a straight-through passage of substantially constant cross section, an inlet at one end of the passage and an outlet at the other end of the passage for the entry and discharge respectively of a working fluid, an annular nozzle opening into said passage intermediate the inlet and outlet ends thereof, an inlet communicating with the nozzle for the introduction of a transport fluid, a mixing chamber being formed within the passage downstream of the nozzle, the nozzle being so disposed and configured that in use a supersonic shock wave is created within the mixing chamber by the introduction of the transport fluid.

The transport fluid is preferably a condensable fluid and may be a gas or vapour, for example steam.

According to a second aspect of the present invention a fluid mover includes a hollow body provided with a straight-through passage of substantially constant cross section, an inlet at one end of the passage and an outlet at the other end of the passage for the entry and discharge respectively of a working fluid, an annular steam nozzle opening into said passage intermediate the inlet and the outlets thereof, a steam inlet communicating with the nozzle for the introduction of steam, a mixing chamber being formed in the passage downstream of the nozzle, the nozzle being so disposed and configured that in use a supersonic shock wave is created in the mixing chamber by the introduction of steam.

Preferably the nozzle is located as close as possible to the projected surface of the working fluid in practice and in this respect a knife edge separation between the transport fluid or steam and the working fluid

stream is of advantage in order to achieve the requisite degree of interaction. The angular orientation of the nozzle with respect to the working fluid stream is of importance and may be narrow.

In some embodiments of the present invention a series of nozzles is provided lengthwise of the passage and the angular orientation of the nozzles may vary from one to the other dependent upon the effect desired. In the case where a series of nozzles is provided the number of operational nozzles is variable.

The or each annular nozzle may be continuous or may be discontinuous in the form of a plurality of apertures arranged in the form of an annulus. Each aperture may be helically formed in order in practice to give a swirl to the flow of the working fluid.

The mixing chamber of the present invention may be of variable length in order to provide a control on the extent of the supersonic shock wave which dictates the point at which collapse or implosion of the steam, *i.e.* condensation and pressure drop, occurs thus affecting the performance of the fluid mover. The length of the mixing chamber is thus chosen to provide the optimum performance regarding momentum transfer. In some expressions of the invention the length may be adjustable in situ rather than predesigned in order to provide a measure of versatility. The collapse of the steam gives rise to an implosive force which also influences the entrapped working fluid within the annular steam stream to the extent that a pinching effect takes place. Accordingly the steam collapse is focused and the working fluid induced thereby is directionalised.

A cowl may be provided downstream of the outlet from the passage in order to enhance the collapse effect and to harness the pressure and to accelerate an additional volume of the working fluid stream.

The fluid mover may also be provided with an air inlet nozzle provided in the passage intermediate the inlet and the outlet. The air nozzle may be annular and may be located upstream or downstream of or coincident with the annular nozzle for the transport fluid or steam.

The air inlet or other inlets which may be provided in the passage, may be used for the introduction of other gases or of other additives that may for example be treatment substances for the working fluid or may be particulates in powder or pulverulent form and used to seed the working fluid.

In a further embodiment of the present invention the fluid mover is disposed within a chamber provided with an inlet and an outlet, the inlet diverging to a central section of constant cross section in which the fluid mover is located and the chamber converging towards the outlet thereof. In this arrangement the working fluid is induced through the fluid mover and also around it within the confines of the chamber.

The fluid mover may be of circular form or may be of rectilinear form.

The fluid mover of the present invention may also be used in heating applications where the heat in the case of steam when used as the transport fluid is employed since necessarily the working fluid will receive heat from the steam.

According to a third aspect of the present invention a method of moving a working fluid includes presenting a fluid mover to the fluid, the mover

having a straight-through passage of substantially constant cross section, applying an annular stream of a transport fluid to the passage through an annular nozzle, generating a supersonic shock wave within the passage downstream of the nozzle, inducing flow of the working fluid through the passage from an inlet to an outlet thereof, modulating the shock wave to vary the working fluid discharge from the outlet, and causing the collapse of the transport fluid thereby to create a region of low pressure to induce flow of the working fluid through the passage.

The transport fluid is preferably a condensable fluid and may be a gas or vapour, for example steam.

According to a fourth aspect of the present invention a method of moving a working fluid includes presenting a fluid mover to the fluid, the mover having a straight-through passage of substantially constant cross section, applying an annular stream of steam to the passage through an annular nozzle, generating a supersonic shock wave within the passage downstream of the nozzle, inducing flow of the working fluid through the passage from an inlet to an outlet thereof, modulating the shock wave to vary the working fluid discharge from the outlet, causing the collapse of the steam by virtue of condensation thereof to create a region of low pressure thereby to induce working fluid flow through the passage.

In carrying out the method of the present invention the creation of a shock wave is occasioned by the design of the nozzle interacting with the setting of the desired parametric conditions, for example in the case of steam as the transport fluid the pressure, the dryness or steam quality and temperature to achieve the required performance of the annular steam nozzle.

The fluid mover of the present invention may be employed in a variety of applications ranging from marine propulsion, where the mover is submersed within a body of fluid, namely the sea or lake or other body of water, to its use as a pump or mixer or aerator. In its application to pumping a variety of working fluids may be moved and may include liquids, solids, liquids with solids in suspension, slurries, sludges and the like. It is an advantage of the straight-through passage of the mover that it can accommodate rogue material that might find its way into the passage. The velocity and pressure generated within the passage and enhanced by the collapse of the transport fluid or steam are such as to ensure rapid movement through the passage. Such an advantage is also of particular import in the use of the fluid mover as a propulsion unit in the marine field where flotsam and jetsam can be a serious problem inhibiting the smooth running of more conventional propulsion units.

By way of example, four embodiments of a fluid mover in accordance with the present invention are described below with reference to the accompanying drawings in which:

Figure 1 is a cross sectional elevation of a first embodiment;
Figure 2 is a cross sectional elevation of a second embodiment with respective end views shown;
Figure 3 is a cross sectional elevation of a third embodiment with respective end views shown; and
Figure 4 is a cross sectional elevation of a fourth embodiment with respective end views shown.

Like numerals of reference have been used for like parts throughout the specification.

Referring to Figure 1 there is shown a fluid mover 1 comprising a housing 2 defining a passage 3 providing an inlet 4 and an outlet 5, the passage 3 being of substantially constant circular cross section.

The inlet 4 is formed at the front end of a protrusion 6 extending into the housing 2 and defining exteriorly thereof a plenum 8 for the introduction of a transport fluid, the plenum 8 being provided with an inlet 10. The protrusion 6 defines internally thereof part of the passage 3. The distal end 12 of the protrusion 6 remote from the inlet 4 is tapered on its relatively outer surface at 14 and defines an annular nozzle 16 between it and a correspondingly tapered part 18 of the inner wall of the housing 2, the nozzle 16 being in flow communication with the plenum 8. The nozzle 16 is so shaped as in use to give supersonic flow.

In operation the housing 2 in one application is disposed in a body of a working fluid (not shown), for example water, the inlet 4 being connected to a source of a transport fluid such as steam. Introduction of the steam into the fluid mover 1 through the inlet 10 and plenum 8 causes a jet of steam to issue forth through the nozzle 16. The parametric characteristics of the steam are selected whereby in use a supersonic shock wave is generated within the passage 3 downstream of the nozzle 16 in a section of the passage operating as a mixing chamber. In operation the shock wave is created in the mixing chamber and is maintained at an appropriate distance within mixing chamber. The steam jet issuing from the nozzle occasions induction of the working fluid through the passage 3 which because of its constant dimension presents no obstacle to the flow. At some point determined by the position of the standing shock wave, the steam collapses or implodes and thus condenses causing a reduction in pressure which enhances the induction of fluid through the passage 3.

Additionally it has been observed that the collapse of the steam, which is part of the mechanism by which the invention functions, does not give rise to a tell-tale wake and therefore the physical fluid signature of the fluid mover is thus of low level.

Figure 2 shows a second embodiment similar to that illustrated in Figure 1 save that an air inlet 30 and plenum 32 are provided in the housing 2, together with a further annular nozzle 34 formed at a location coincident with that of the nozzle 16. In this instance in use air is introduced to the passage 3 to aerate the flow whereby a three-phase condition is realised constituted by the liquid phase of the body of water, the steam and the air.

The use of air may assist in the suppression of cavitation thus reducing physical deterioration of the housing. In this connection the suppression of cavitation has the beneficial effect of reducing noise levels and accordingly the sonic signature of the fluid mover is thus diminished. This attribute in practice would have benefits where the mover is to be used in its marine propulsion application, particularly for military usage, where running as silently as possible is advantageous.

The air nozzle 34 or another nozzle or nozzles may alternatively form the inlet for other fluids for use in mixing or treatment purposes. For example, a further air nozzle may be provided in the passage to provide aeration of the working fluid if necessary.

Referring now to Figure 3 the fluid mover of Figure 1 is provided with a frusto-conical cowl 40 adjacent the outlet 5 of the passage 3. Its disposition at this location allows a further concentration of the induction effect by virtue of the working fluid being drawn in not only through the

inlet 4 but also through the annulus 42 formed between the outlet 5 and the internal wall of the cowl 40. A venturi effect is produced and thus affords a further acceleration of the flow through the combination of the housing and the cowl and thus the thrust is enhanced. The position of the cowl may be varied in order to give the desired effect.

With reference to Figure 4, the embodiment of Figure 1 is disposed centrally within a casing 50 having a diverging inlet portion 52 having an inlet opening 54, a central portion 56 of constant cross section, leading to a converging outlet portion 58 having an outlet opening 60. In use the inlet and outlet openings 54 and 60 are in flow communication with a body of a working fluid either therewithin or connected to a conduit. In operation the working fluid is drawn through the casing 50 with flow being induced around the housing 2 and also through the passage 3 of the mover which is of similar design to that shown in Figure 1. The convergent portion 58 of the casing provides a means of enhancing the accelerative effect of the fluid mover and thus improves the thrust of the fluid flow.

The present invention provides the means whereby the generation of a supersonic shock wave within the fluid mover and its extension therefrom with the attendant condensation of the transport fluid, namely steam, the thrust afforded is enhanced by virtue of the momentum transfer from the steam to the working fluid giving it added acceleration. The action of the supersonic shock wave is controllable by varying the geometry of the fluid mover and the parametric conditions of the transport fluid.

As has been indicated above, the present invention possesses a number of advantages in its operational mode and in the various applications to which it is relevant. For example the 'straight-through' nature of the fluid mover having a substantially constant cross section means that not

only will fluids containing solids are easily handleable but also any rogue material will be swept through the mover without impedance. The suppression of cavitation effected by aeration of the working fluid which also reduces surface friction losses, also diminishes its sonic signature and accordingly benefits accrue in terms of the application of the invention in the field of marine propulsion particularly in the military arena.

In the case where only two phases are present, the steam collapse which gives the momentum transfer to the working fluid only gives a transient wake and accordingly the physical flow signature of the mover is small and short-lived. Again benefits are derived from such a mechanism.

The present invention thus affords wide applicability with improved performance over the prior art proposals in the field of fluid movers.

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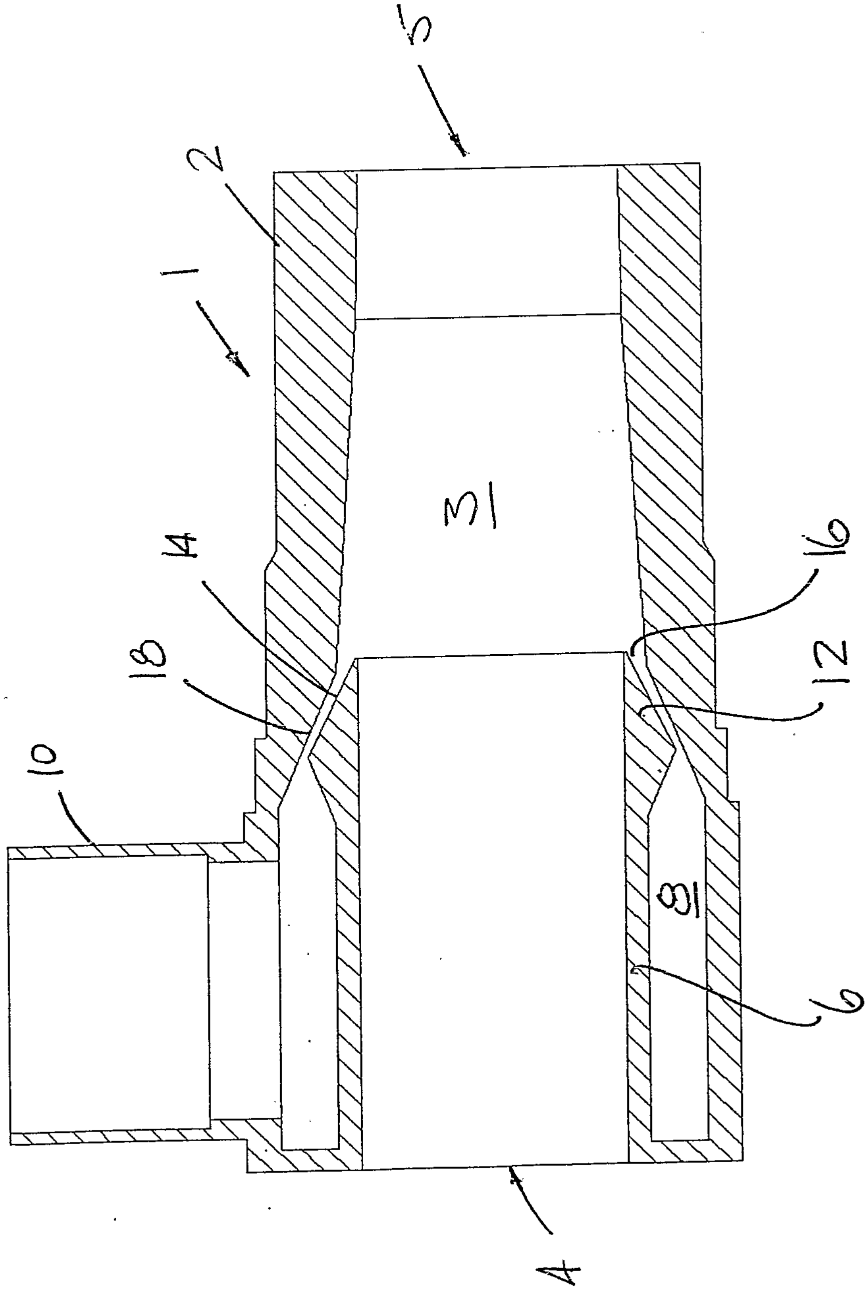


FIGURE 1

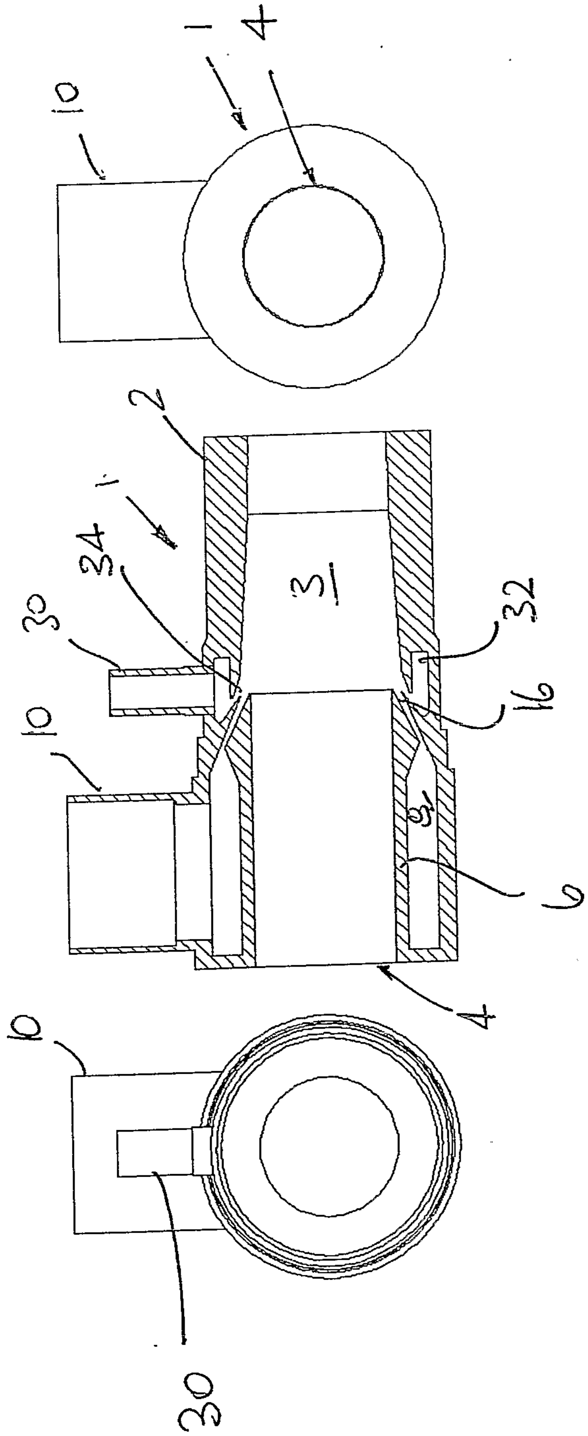


FIGURE 2

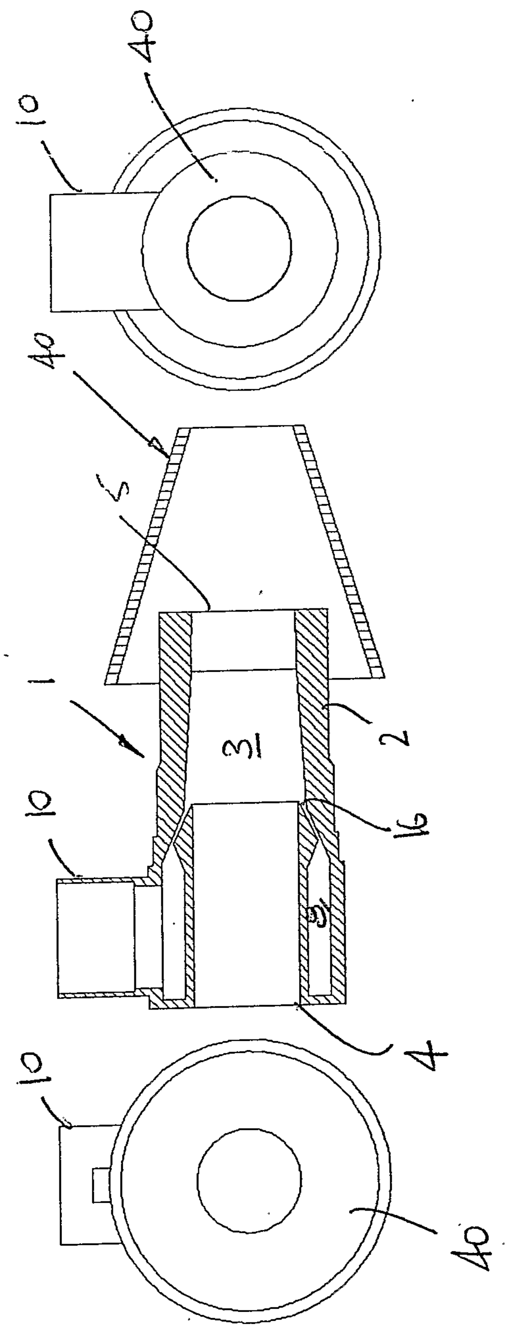


FIGURE 3

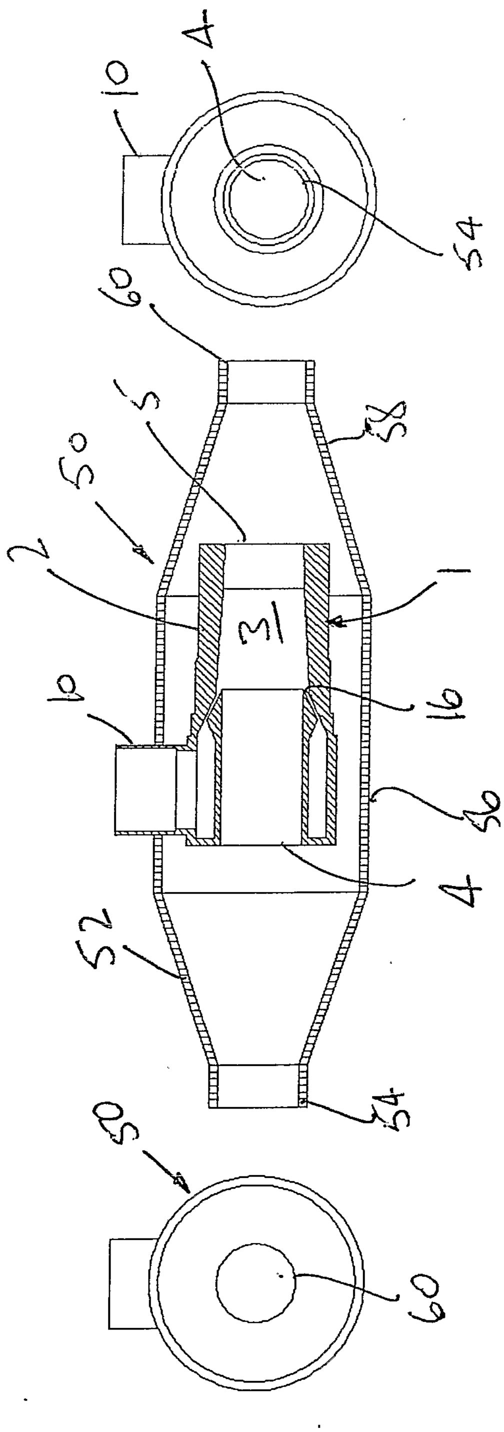


FIGURE 4

PCT Application
GB0304400